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Reliability of estimating standing crop of earthworms by hand sorting

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1. Introduction

Several different methods have been used to estimate earthworm population densities (cf. Satchell 1969, and Bouche 1969). Hand sorting is the most common method and is also used to test other methods. The reliability of hand sorting has been tested by RAW (1960) and Nelson and Satchell (1962).

Raw (1960) tested the reliability of hand sorting by sieving and floatating samples of soil that had already been sorted by hand. The hand sorting of nine samples from wet hill grassland soil with a thick carpet of vegetation brought to light 52% of the total number of earthworms found (85% by weight). There was a greater degree of reliability in hand sorting certain other types of soil. Raw does not report the time taken for this work.

Nelson and Satchell (1962) tested the reliability of hand sorting by sorting soil samples containing known numbers of earthworms. Ninetythree per cent of the earthworms (99% by weight) were recovered by hand sorting. There were marked difference in the reliability of recovery of small and large earthworms. The sortings were carried out by two persons, who took, on the average, 143 minutes and 80 minutes to sort each sample unit. The size of the sample units was 10 × 10 × 10 inches (ca. 25 × 25 × 25 cm). By means of re-sorting five of the missing 7% were recovered.

Nelson and Satchell (1962) also had sorted by hand 10 sample units, measuring 10 × 10 × 10 inches, from a pasture field. The sortings were carried out by two persons, whose work was checked by a third person by re-sorting. Of the total of 698 earthworms found, 97% were found at the first sorting (99% by weight). The time taken for the first sorting was 259 minutes and 134 minutes, on the average, for the two persons. They knew that their samples would be re-sorted.

Ordinary hand sorting, taking 2—4 hours per sample, seems to be the most efficient method at present of estimating the number and the biomass of earthworm populations. Judging from Nelson and Satchell (1962) the best way of testing the reliability in natural soils would be to re-sort samples already sorted.

In the present article we report the results of re-sorting soil samples from two investigation areas near Uppsala, Sweden. This study is part of the International Biological Programme project being carried out in central Sweden. The aim was to assess the reliability of hand sorting with regard to the number, weight and species of earthworms in the types of soil concerned.

2. Method

The area of the sample unit was 25 × 25 cm and the depth was 20 cm. The samples were sorted by hand in the laboratory on a light-coloured surface in good lighting. They were then sorted a second time in the same way. On the first occasion the staff were unaware that the samples would be re-sorted. The first and the second sortings of one and the same sample were carried out by different persons.

Thirteen of the sample units were taken in deciduous woodland (Andersby), where *Quercus robur* L., *Betula pendula* ROTH and *Corylus avellana* L. are the dominant species in the high and low canopy layers and where *Anemone hepatica* L., *A. nemorosa* L., *Calamagrostris arundinacea* (L.) ROTH and many other species are to befound in the field layer. The bottom layer consists of mosses. The samles were taken in a mull soil with a distinct admixture of clay. The content of organic matter is of the order of 10—20 per cent of the dry substance.

Twelve of the sample units were taken in an old field of loose fen peat soil. The vegetation is dominated by *Elytrigia repens* L. There are no bushes or trees and practically no bottom layer. The soil is mixed to some extent with the underlying clay, but the clay element is usually slight. This is also clear from the fact that in most cases the content of organic matter was over 50 % of the dry substance.

The 13 sample units from the deciduous woodland took, on the average, 91 minutes at the sorting and 66 minutes at the second. The corresponding times for the 12 samples from the abandoned soils were 147 minutes and 160 minutes respectively. On both sampling occasions the soil was rather damp.

3. Results

In comparing the first and the second sortings, the sexually immature earthworms were separated from the sexually mature. The results are shown in Tables 1—2.

Table 1 Numbers of earthworms in 13 samples from deciduous woodland resp. in 12 samples from abandoned soils found in two consecutive hand sortings

Species	deciduous woodland				abandoned soils			
	1st sorting		2nd sorting		1st sorting		2nd sorting	
	adult	juv.	adult	juv.	adult	juv.	adult	juv.
Lumbricus	**11**	**27**	**0**	**6**	**6**	**12**	**0**	**2**
rubellus	*100*	*82*	*0*	*18*	*100*	*86*	*0*	*10*
Dendobaena	**2**	**17**	**0**	**10**	**6**	**10**	**2**	**3**
octaedra	*100*	*63*	*0*	*37*	*75*	*77*	*25*	*23*
Allolobophora	**14**	**177**	**0**	**10**	**3**	**34**	**0**	**16**
caliginosa	*100*	*95*	*0*	*5*	*100*	*68*	*0*	*32*
A. rosea	**15**	**56**	**0**	**10**	**13**	**34**	**0**	**2**
	100	*85*	*0*	*15*	*100*	*94*	*0*	*6*
Total	42	277	0	36	28	90	2	23

Note: Absolute (bold) and relative (italics) numbers. Sample size 10×10×8 inches (ca. 25×25×20 cm) per unit.

Table 3 Total fresh weight of earthworms found in the first and second sortings (cf. Table 1)

	Total weight (g) found in 1st hand sorting	Total weight (g) found in 2nd hand sorting	Percentage weight found in 1st hand sorting	Percentage weight found in 2nd hand sorting
Deciduous woodland (n = 13)	36.66	1.02	97	3
Abandoned soils (n = 12)	15.36	0.61	96	4

The 61 earthworms found in the second sorting all weighed less than 0.160 g f. w. Individual, sexually mature *Dendrobaena octaedra* (SAVIGNY) from the old field weighed between 0.080 and 0.250 g (22 specimens). The other three species, *Lumbricus rubellus*

4. Discussion

The results show that hand sorting of the sample units of the size in question at 1.5 hours per sample (deciduous woodland) and 2.5 hours per sample (old field) gives a good estimate of the numbers of large earthworms. In the other hand, small earthworms will be greatly underestimated. All earthworms weighing more than 0.16 g were probably found in the first examination of samples. In general we may therefore follow Satchell (1969) in asserting that the method seems to yield a satisfactory rate of discovery for individual earthworms weighing more than 0.2 g f. w.

An important number of sexually immature earthworms of the four species mentioned above and some small, sexually mature earthworms, mainly *D. octaedra*, risk remaining undiscovered in hand sorting.

For the two different soils investigated, the hand sorting method, taking the time which we took, seems to yield a satisfactory results for an estimate of the biomass, since 97 % and 96 % respectively of the standing crop, expressed as the fresh weight of the earthworms found, were discovered at the first hand sorting. On the other hand, the method seems to be less suitable for studies which require accurate estimates of the younger aga-groups.

In addition to the size of the earthworms, the condition and structure of the soil probably play a large part in the reliability of hand sorting. The times taken by different sorters and the care with which they work are of course also of the greatest importance for the result.

5. Acknowledgement

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6. Zusammenfassung

Die Zuverlässigkeit der Handsortierung von Bodenproben wurde durch zweimalige Sortierung der Proben überprüft. Die Probengröße betrug 25 × 25 × 20 cm. In einem Versuch mit 13 Proben von einem Laubwaldboden wurden 90 % der gesamten Individuenzahl und 97 % des Gesamtgewichtes in der ersten Handsortierung entdeckt. In einem ähnlichen Versuch mit 12 Proben von Ödland wurden 83 % der Gesamtzahl und 96 % des Gesamtgewichtes in der ersten Sortierung entdeckt. Im Durchschnitt erforderte die erste Handsortierung von Laubwaldproben $1^1/_2$ Stunden und die von Brachlandproben $2^1/_2$ Stunden. Von den vier hier betrachteten Arten (L. *rubellus*, D. *octaedra*, A. *caliginosa* und A. *rosea*) wird vor allem D. *octaedra*, auf Grund der geringen Größe auch der geschlechtsreifen Tiere, bei Handsortierung leicht übersehen. Die Handsortierung scheint eine zuverlässige Schätzung des Regenwurmbesatzes, bei einem Frischgewicht der Individuen von mehr als 0,2 g, zu gewährleisten.

6. References

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